

APPROVAL SHEET FOR SUSPENDED LOAD OPERATIONS

SLO-KSC-1994-004 CHANGE 1

TITLE INSTALLATION OF KEEL TRUNNION TARGET ASSEMBLY ON PAYLOAD ELEMENT USING THE NASA STRONGBACK, CELA, OR IPPLA

DOCUMENT NUMBER/TITLE OMI L7011 PAYLOAD CENTERING IN TEST STAND

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REQUIRED APPROVAL

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**NASA SUSPENDED LOAD OPERATION
ANALYSIS/APPROVAL**

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OPERATION

1. To remove or install the pallet from or into the Payload Segment Structure Integration Trolley (PSSIT).
2. To remove or install the Payload from or into the Canister or Test Stand.

SUPPORTING DOCUMENTS - The associated operational procedure and System Assurance Analyses (SAAs) are as follows:

- OMI L5166, Cargo Element Lifting Assembly (CELA)
- SAA01FS027-002, 27.5 Ton Bridge Cranes - O&C
- SAA21HASI-001, Cargo Element Lifting Assembly - SSPF

GENERAL DESCRIPTION

1. Removal or installation of the pallet from or into the PSSIT requires a maximum of four people under the suspended pallet and CELA to remove or install a set of pallet support struts. One person will be required under the suspended load to perform static ground connections.
2. Removal or Installation of the Payload from or into the Canister requires a maximum of two people under the suspended load depending on the number of keel trunnions (one person per keel trunnion) to guide each keel trunnion into the corresponding keel latch. One person will be required under the suspended load to perform static ground connections.
3. Removal or Installation of the Payload from or into the Canister or Test Stand requires a maximum of three people under the CELA Counterbalance Drive Motors to guide the trunnion from or into the corresponding trunnion retention fitting.

- OMI L5166, Remove Pallet from PSSIT
- OMI L5166, Install Pallet into PSSIT
- OMI L5166, Remove Payload from Canister or Test Stand
- OMI L5166, Install Payload into Canister or Test Stand

These tasks require personnel to be in the area of increased hazard directly under the suspended load for CELA operations. OMI L5166 is the controlling procedure used in the Operations and Checkout Building (O&C) for these operations.

RATIONALE/ANALYSIS - The suspended load tasks comply with the NASA Alternate Safety Standard as follows:

Alternate Standard Requirement #1a:

1. These tasks cannot be conducted without placing personnel beneath the suspended load because there is no other access to the hardware attach points.
2. The pallet is tapered by design with the support struts located inboard on the tapered portion of the pallet, which places personnel beneath the CELA and part of the pallet.

During the pallet operation, the load must be hoisted above its appropriate holding fixture to provide access for hardware removal or installation. As a result, there are no operational or procedural means to eliminate personnel exposure to the suspended load because of lack of access to the attach points.

The design of additional support structures for the load is not feasible because access to the attach points would be blocked.

3. During installation/removal of the payload into the canister, the technician must reach beneath the suspended payload to guide the keel trunnion into/out of the keel latch. There is no alternate access to the keel trunnion located underneath the payload, and the cover cannot be installed or removed while the payload is in the payload canister. This physical limitation precludes any design, operational, or procedural changes that would eliminate personnel exposure to a suspended load.

4. During installation/removal of the payload into the canister or test stand, the technician must be directly beneath the suspended load to guide the trunnions into/out of the retention fittings. There is no alternate access to the trunnion retention fittings located underneath the CELA Counterbalance Drive Motors. This physical limitation precludes any design, operational, or procedural changes that would eliminate personnel exposure to a suspended load.

Alternate Standard Requirement #1b - The possible use of a secondary support system, to catch the load in the event of a crane failure, was analyzed. It was determined that the use of a secondary support system was not feasible because of positioning of the pallet over the PSSIT or positioning of the payload in the canister.

Alternate Standard Requirement #1c

- The maximum number of personnel allowed under the suspended pallet and CELA for removal or installation of the pallet support struts (for removal or installation of the pallet from or into or out of the PSSIT) is four.
- The maximum number of personnel allowed under the suspended load while guiding the keel trunnion into or out of the keel latch is one person per keel trunnion.
- One person will be allowed under the suspended load to perform static ground connections, if required.
- Three persons are allowed under the CELA Counterbalance Drive Motors to guide the trunnions during installation or removal into or from the trunnion retention fittings
- Also, during contingency ingress to or egress from the canister, only man-loaded personnel may pass under the suspended CELA.

Alternate Standard Requirement #1d

1. Removal or installation of the pallet support struts will be accomplished as quickly and safely as possible to minimize exposure time. It will take four

persons up to 30 minutes to remove or install the pallet support struts for CELA operations.

2. Guiding the keel trunnions into the keel latches will be accomplished as quickly and safely as possible to minimize exposure time. It will take for either one or two persons (one person per keel trunnion) up to 60 minutes to guide the keel trunnions into the keel latches.
3. Guiding the payload trunnions into or out of the retention fittings on the canister or the test stand will take two persons (one per trunnion) and a task leader up to 60 minutes to ensure the payload is installed or removed properly.
4. Ground connections will be accomplished as quickly and safely as possible to minimize exposure time. It will take up to 10 minutes for one person to perform the grounding operation.

Alternate Standard Requirement #4 - OMI L5166 permits only the approved number of persons under the suspended loads addressed in this analysis. The OMI is available on site for inspection during the operation.

Alternate Standard Requirement #6 - The suspended load operations addressed in this analysis involve one of the 27.5 ton bridge cranes. The cranes are designed, tested, inspected, maintained, and operated in accordance with the NASA Safety Standard for Lifting Devices and Equipment, NSS/GO-1740.9.

The 27.5 ton crane hoists are equipped with two magnetic holding brakes (one on the motor shaft and one on the gear reducer input shaft extension), each capable of holding the load up to the crane's rated capacity. Each brake's ability to hold the rated load (27.5 tons) is verified annually. The cranes are designed to meet a 5 to 1 safety factor based on ultimate strength for the hoist load bearing components.

The 27.5 ton cranes are load tested annually at 100% of their rated capacity. Detailed preventive maintenance is performed monthly, quarterly, semiannually, and annually on the cranes to ensure proper operation. A detailed inspection of the lifting slings is performed annually. Nondestructive testing of the slings and crane hooks is performed annually.

The weight of CELA and the pallets is 44,000 lbs, which is 80% of the crane's capacity. The lifting sling is rated at 36,500 lbs and is designed to meet a 5 to 1 safety factor based on ultimate strength.

Alternate Standard Requirement #7 - A System Assurance Analyses (SAAs) has been completed on the 27.5 ton bridge cranes in the O&C. The SAA includes a Failure Modes and Effects Analysis/Critical Items List (FMEA/CIL) and a hazard analysis (see supporting documents).

The SAA identifies one single failure point (SFP), the hoist gear reducer, which transmits power and reduces rotational speed from the hoist motor to the rope drum. A sheared key or broken teeth would cause interruption of the load path at the gearbox. This failure would result in the load dropping, which could cause loss of life and/or payload.

There is no history of failure with the SFP in the critical failure mode. A detailed inspection of the gear reducer is performed monthly, and gear reducer oil samples are verified annually. The use of high-quality, reliable components and a comprehensive maintenance, inspection, and test program, including preoperational checks, ensures that the crane systems operate properly.

The associated SAA CIL Sheets identify all the rationale for accepting the risk of the SFPs, including design information, failure history, and the operational controls in effect to minimize the risks (maintenance, inspection, test, etc.).

Alternate Standard Requirement #8 - Visual inspections for cracks or other signs of damage or anomalies are performed on the hoist hooks, hoist beams, hoist cables, hoist rod assemblies, and hoist fittings, and crane functional checks are performed before each operation per NSS/GO-1740.9.

Alternate Standard Requirement #9 - Trained and licensed crane operators shall remain at the hoist controls while personnel are under the load.

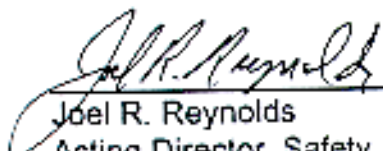
Alternate Standard Requirement #10 - Appropriate safety control areas are established before initiating operations. Only the minimum number of people (manloaded in the procedure) will be permitted in this area.

Alternate Standard Requirement #11 - A pretask briefing and a safety walkdown of the area are conducted prior to the lift to ensure that all systems and personnel are ready to support. All participants are instructed on their specific tasks and warned of any hazards involved. Following any crew change, the new personnel are instructed by the task leader on their specific tasks and warned of any hazards involved.

Alternate Standard Requirement #12 - Personnel beneath the suspended load will be in voice contact with the hoist operator and/or task leader. Upon loss of communication, the operation shall stop immediately, personnel shall clear the hazardous area, and the load shall be safed. Operations shall not continue until communications are restored.

Alternate Standard Requirement #13 - Personnel working beneath the load shall be in continuous sight of the hoist operator and/or task leader.

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